NUCLEAR ENERGY RESEARCH INITIATIVE

Enhancements to High Temperature In-Pile Thermocouple Performance

PI: John Crepeau, University of Idaho

Collaborators: Idaho National Laboratory

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Program Area: Advanced Fuel Cycle Initiative

Project Description

There are insufficient data to characterize the performance of new reactor materials in high temperature, radiation conditions. To evaluate candidate material performance, robust instrumentation is needed that can survive these conditions. Traditional methods for measuring temperature in-pile degrade at temperatures above 1,080ºC or de-calibrate due to transmutation. During the last year, the Idaho National Laboratory launched an effort to develop temperature measurement methods suitable for long duration, high temperature in-pile testing. Initial results indicate that specialized alloy thermocouples fabricated from molybdenum/niobium-1% zirconium have the potential to provide the desired accuracy for a longer duration. Although the performance of these thermocouples appears promising, there are several options which can potentially enhance their lifetime and reliability.

The major research objective of this project is to quantify the impact of candidate enhancements related to alloy materials, geometry, and fabrication techniques on thermocouple performance. Based on these evaluations, improved thermocouple designs will be fabricated and tested at high temperatures for long durations to quantify thermocouple accuracy, reliability, and lifetime. Ultimately, an optimized thermocouple design will be recommended for future fuel testing.

Workscope

This project comprises the following major tasks:

- Evaluate alternate alloys
  - Ductility and embrittlement assessments
  - Stability and thermal cycling demonstration tests
- Evaluate alternate geometry
  - Fabrication of alternate geometries
  - Stability and thermal cycling demonstration tests
- Evaluate alternate fabrication techniques
  - Fabrication of alternate geometries
  - Stability and thermal cycling demonstration tests
  - Optimized thermocouple design